REMARKS

Applicants acknowledge receipt of an Office Action dated May 26, 2009. In this response, Applicants have amended claim 1. Claims 2-15 have been cancelled without prejudice or disclaimer in order to permit allowable subject matter to issue without further delay. No new matter has been added. Support for claim 1 may be found on page 5, lines 27- page 6, line3; page 12, line 3- page 14, line 14, and Fig. 2. Following entry of these amendments, claim 1 is pending in the application.

Applicants respectfully request reconsideration of the present application in view of the foregoing amendments and in view of the reasons that follow.

Rejections Under 35 U.S.C. § 103

On page 2 of the Office Action, the PTO has rejected claim 1 under 35 U.S.C. § 103(a) as allegedly being unpatentable over U.S. Patent 5,515,683 to Kessler (hereafter "Kessler") in view of U.S. Patent No. 5,006,178 to Bijvoets (hereafter "Bijvoets"). Applicants respectfully traverse this rejection for at least the reasons set forth below.

Kessler fails to teach a Peltier effect heat transfer circuit system including, among other things, "a first coupling member connecting the second longitudinal end of the first conductive member of one of the thermoelectric transducers electrically and serially to the second longitudinal end of the first conductive member of another of the thermoelectric transducers;" and "a second coupling member connecting the second longitudinal end of the second conductive member of one of the thermoelectric transducers electrically and serially to the second longitudinal end of the second conductive member of another of the thermoelectric transducers...", as recited in claim 1.

Kessler teaches two different Peltier elements connected in a circuit, but does not provide any structure for the conductive members of the elements. For example, Kessler generally shows, in Fig. 5, a construction that a Peltier element circuit where two Peltier elements (1, 2) having different capacities are serially connected is provided with a bypass diode (10) for reducing a thermal load that is applied to a Peltier element having a smaller capacity during heating operation, but does not describe the specific structures of elements 1 and 2.

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Bijvoets fails to cure the deficiencies of Kessler. For example, Bijvoets fails to teach or suggest at least the structure of claim 1 as recited above.

Bijvoets teaches a plurality of thermoelectric elements with each element provided with two element halves of opposite conductivity types (i.e., a p-type first half and an n-type second half) . Applicants submit, however, that Bijvoets provides a different structure than that of claim 1. For example, claim 1 requires a first coupling member connecting the second longitudinal end of the first conductive member of one of the thermoelectric transducers electrically and serially to the second longitudinal end of the first conductive member of another of the thermoelectric transducers. Bijvoets, however, teaches a first coupling member electrically and serially connecting the second longitudinal end of the first conductive member of one thermoelectric transducer to the second longitudinal end of the second conductive member of another thermoelectric transducer. In other words, where claim 1 of the presently claimed invention requires the second end of each of two first conductive members of different transducers to be electrically and serially connected by a first coupling member, Bijvoets instead teaches a first conductive member (a p-type half) of one element electrically and serially connected to a second conductive member (an n-type half) of another transducer.

Claim 1 further requires a second coupling member serially and electrically connecting the second longitudinal end of the second conductive member of one of the thermoelectric transducers to the second longitudinal end of the second conductive member of another of the thermoelectric transducers. Instead, however, Bijvoets teaches a second coupling member serially and electrically connecting the second longitudinal end of the second conductive member of one thermoelectric transducers to the first conductive member of another thermoelectric transducer. In other words, where claim 1 requires the second end of each of two second conductive members from different transducers to be electrically and serially connected by a second coupling member, Bijvoets instead teaches a second conductive member (an n-type half) of one transducer electrically and serially connected to a first conductive member (a p-type half) of another transducer.

Applicants submit that even if the construction of Bijvoets is applied to each of the Peltier elements of Kessler, as attempted by the Office, the combination results in a construction that is different from a construction of claim 1 which is shown as an exemplary

embodiment in Fig. 2 of the instant application. In effect, the construction based on combination cannot produce advantageous effects similar to the present invention.

Hereafter, Applicant submits further support against the Office's unsuccessful attempt to rely on Bijvoets supplement the failures of Kessler. In general, the efficiency of cooling and heating based on heat generation and heat absorption phenomena according to the Peltier effect, is evaluated on the basis of a value of Coefficient of Performance (COP) defined as COP = (thermal power transferred by electronic heat pumping)/(electrical input power). The efficiency of cooling and heating is evaluated to increase with an increase in COP. In the thermoelectric conversion system according to the present invention, part of power supplied is lost as a Joule heat at the copper wire. However, this power loss is negligibly small.

Additionally, Bijvoets generally states in from column 1, line 45 to column 2, line 31 that the semiconductor pieces are shortened, and an electrical conductor made of copper or the like having a negligible thermoelectric effect and a negligible electrical resistivity as compared with the semiconductor piece is used as an intermediate piece electrically connecting at both ends the semiconductor pieces to each other, so as to reduce a Joule heat due to electrical resistance, and to enhance an efficiency of thermoelectric conversion. However, Bijvoets seems to incorrectly try to demonstrate technological, physical, and functional advantages of the disclosed thermoelectric device, only paying attention to the intermediate piece having the small electrical resistivity and connecting the semiconductor pieces at both ends. It is however true that, when attention is paid to physical phenomena which occur in the entire thermal electric conversion circuit of the thermoelectric device of Bijvoets, including the semiconductor pieces at both ends and the intermediate piece, the efficiency of the thermoelectric conversion circuit according to that thermoelectric device is assuredly reduced due to the addition of the Joule heat loss at the intermediate pieces.

For example, Applicants bring to the Office's attention Bijvoets at column 5, lines 5-15, and EXAMPLE I where the length of Bismuth Tellurium (BiTe) based semiconductor end pieces 8 (P-type) and 10(N-type) are respectively equal to about 2.5 mm. Here, the total length of the pair of end pieces top portion 8 and bottom portion 8 (or top portion 10 and bottom portion 10), which is equal to about 5 [mm], is approximately the same as the length of semiconductor piece P (or N) of a Peltier module typically available on the market. It is true that when the current flows in the circuit including the intermediate pieces 9 shown in the

drawing of Bijvoets, the Joule heat loss at the intermediate pieces 9 are added to increase the whole Joule heat loss of the thermoelectric conversion circuit, as compared with the case where intermediate pieces 9 are not present. Unless intermediate pieces 9 are in a superconductor state, a physical phenomenon is impossible in which when the current is flowing through intermediate pieces 9, the Joule heat loss at intermediate pieces 9 is equal to zero. The electrical resistivity of a semiconductor provided at normal temperatures is dependent upon the temperature. A temperature at which even a high temperature superconductor now developed is brought to be in a superconductive state is considerably lower than normal temperatures. Applicant submits that the foregoing statements as disclosed in Bijvoets are incorrect from technological, physical, and functional viewpoints.

Bijvoets also states, in column 3, lines 7 to 18, that "[b]ecause a P-conducting end piece 8 and an N-conducting end piece 10 are respectively connected at each bridge 5, the enhancement or depletion process of free electrons mentioned above will take place in the bridges 5 with the passage of current. As a result thermoelectric effects are created in the bridges 5, therefore. At both ends of the intermediate pieces 9 there is semiconducting material of the same conductivity type and there will be at least substantially no enhancement or depletion process. As a result hardly any or no thermoelectric effects at all are created in the intermediate pieces 9, therefore."

As is known to persons of ordinary skill in the art related to the presently claimed invention, thermoelectric effects include the Peltier effect, the Seebeck effect, and the Thomson effect. Accordingly, Applicant submits that in Bijvoets, the thermoelectric effects actually occur in the intermediate pieces 9. For example, when the current is flowing in the circuit from left to right, for example in the device shown in the drawing of Bijvoets, the current is flowing through a π type Peltier element closer to plate 3 in the order of components 9, 8, 5, 10 and 9. Thus, if heat generation occurs at the junction between the end piece 8 and bridge 5, heat absorption occurs at the junction between the end piece 8 and the intermediate piece 9, heat generation occurs at the junction between the end piece 10 and the bridge 5, and heat absorption occurs at the junction between the end piece 10 and the intermediate piece 9. When the current is flowing in the circuit in the reverse direction, heat absorption occurs at the junction between the end piece 8 and bridge 5, heat generation occurs at the junction between the end piece 8 and the intermediate piece 9, heat absorption occurs at

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the junction between the end piece 10 and the bridge 5, and heat generation occurs at the junction between the end piece 10 and the intermediate piece 9. Heat is conducted within the bridge 5 and within the intermediate piece 9, so that the temperatures of the bridge 5 and the intermediate piece 9 in a stead-state are determined in dependence upon the thermal capacities of the bridge 5 and the intermediate piece 9.

Bijvoets also discloses in column 4, lines 16 to 19, that "[a]ccording to the invention, however, intermediate pieces 9 are used which, dependent on the conductivity type of the end pieces 8 or 10, will behave as P-type or N-type material." Applicant, however, submits that is incorrect at all in view of physics for reasons that follow. Bijvoets specifies that the end pieces 8 and 10 are semiconductors, and the intermediate pieces 9 are made of a material having a high electrical conductivity such as a copper, as described in lines 7 and 8 of column 2 of Bijvoets and recited in lines 44 to 46 of column 5 of Bijvoets. Semiconductors have a band-gap (forbidden band) in the energy band diagram, while a material having a high electrical conductivity such as a copper has no band-gap (forbidden band). Therefore, the intermediate pieces 9 never behaves as P-type or N-type material.

Applicant submits that even if a person having ordinary skill in the art referred to Bijvoets, the reference fails to disclose, teach the subject matter of the presently claimed invention, and teaches away from the claimed invention.

For example, in column 4, lines 24 to 29, Bijvoets discloses that "[t]he thickness of the end pieces 8, 10 is in the order of magnitude of several μm and they may consist of the usual semiconductor material, such as BiTe. Said thickness of the layer is about 0.1% of the conventional length of the element half, as a result of which the losses W2 of Joule heat of the semiconductor material are reduced by the same order of magnitude." Applicant submits that the foregoing statement of Bijvoets leads to adverse effects in terms of thermal conduction, i.e. heat flux due to thermal conduction W3 in equation (3) of Bijvoets, as discussed below.

It is a well known physical fact that the thermal conductivity of copper used for the intermediate pieces 9 is equal to about 400 [W/m/k], and the thermal conductivity of Bi2Te3-based semiconductor used for the end pieces 8, 10 is equal to about 1.5 [W/m/k] at a normal temperature range about from 0°C to 100°C and is equal to about 1/270 the thermal conductivity of copper.

As analyzed above, when the current is flowing from left to right in the circuit shown in drawing of Bijvoets, heat generation occurs at the junction between the end piece 8 and bridge 5, heat absorption occurs at the junction between the end piece 8 and the intermediate piece 9, heat generation occurs at the junction between the end piece 10 and the bridge 5, and heat absorption occurs at the junction between the end piece 10 and the intermediate piece 9, on the side closer to plate 3.

It is to be noted that according to equation (3) of Bijvoets, the quantity of heat transported due to thermal conduction W3 is inversely proportional to the thickness (or length) L. This yields the following equation.

(W3 of end piece 8, 10) / (W3 of intermediate piece 9)

= (about 1.5 [W/m/k] / several [μm)) / (about 400 [W/m/k] / several [mm))

≈[1000/270] ≈3.7

The foregoing equation indicates that the heat flow quantity within end pieces 8 and 10 on the side closer to plate 3 in the drawing of Bijvoets is equal to about 3.7 times the heat flow quantity W3 within the intermediate pieces 9. As a consequence, a heat generation quantity at each junction between bridge 5 and end piece 8 and between bridge 5 and end piece 10 at the side closer to plate 3 in the drawing of Bijvoets and a heat absorption quantity at each junction between intermediate piece 9 and end piece 8 and between intermediate piece 9 and end piece 10 are mutually cancelled. This is true also for the side closer to plate 2 in the drawing of Bijvoets. As a result, even when the current is flowing, there occurs no temperature difference between the two bridges 5 on the sides closer to plates 2 and 3 in the drawing of Bijvoets.

Thus, Applicants submit that the thermoelectric device according to Bijvoets can actually produce no temperature difference, although it is an essential function of thermoelectric device.

Since Bijvoets does nothing to resolve the fundamental deficiencies in Kessler, Applicant submits that no combination of these references can properly render independent claim 1 obvious.

In view of the foregoing, reconsideration and withdrawal of the rejection are respectfully requested.

Double Patenting

On page 4 of the Office Action, the Office has provisionally rejected claim 1 under the judicially created doctrine of obviousness-type double patenting as allegedly being unpatentable over claims 1-34 of copending Application No. 10/727,988. Applicant submit herewith in Appendix A a terminal disclaimer to overcome the rejection.

In view of the foregoing, reconsideration and withdrawal of the provisional rejection are respectfully requested.

CONCLUSION

Applicants believe that the present application is now in condition for allowance. Favorable reconsideration of the application as amended is respectfully requested.

The Examiner is invited to contact the undersigned by telephone if it is felt that a telephone interview would advance the prosecution of the present application.

The Commissioner is hereby authorized to charge any additional fees which may be required regarding this application under 37 C.F.R. §§ 1.16-1.17, or credit any overpayment, to Deposit Account No. 19-0741. Should no proper payment be enclosed herewith, as by a check being in the wrong amount, unsigned, post-dated, otherwise improper or informal or even entirely missing or a credit card payment form being unsigned, providing incorrect information resulting in a rejected credit card transaction, or even entirely missing, the Commissioner is authorized to charge the unpaid amount to Deposit Account No. 19-0741. If any extensions of time are needed for timely acceptance of papers submitted herewith, Applicants hereby petition for such extension under 37 C.F.R. § 1.136 and authorizes payment of any such extensions fees to Deposit Account No. 19-0741.

Respectfully submitted,

Date ___9/28/09___   By _____

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